DOCUMENT RESUME

PS 002 141

ED 032 131

By-Coller, Alan R.; And Others

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New York Univ., N.Y. Inst. for Developmental Studies.
Spons Agency-Carnegie Corp. of New York, N.Y.
Pub Date [68]
Note-20p.
EDRS Price MF-$0.25 HC-$1.10
Descriptors-*Auditory Discrimination, Auditory Perception, *Auditory Tests, *Consonants, Culturally Disadvantaged, Grade 1, Listening Comprehension, Phonemes, Scoring, *Test Interpretation, Test Validity
Identifiers-*Wepman Auditory Discrimination Test

This study examined the relationship between initial and final consonants on two equivalent forms of the Wepman Auditory Discrimination Test (WADT). Subjects were 128 first grade, English-speaking, Negro, disadvantaged children. The two WADT forms each contained 40 different word-pairs. Thirteen word-pairs differed in initial consonant (IPT); 13 differed in final consonant (FPT); four differed in medial vowel (MPT); and 10 word pairs consisted of the same words. Both forms of the test were taped and administered individually to the children. The results indicated (1) there were no apparent differences between Form I and Form II, and (2) significantly higher correct scores were obtained on the IPT than on the FPT. Individual differences of pattern on IPT and FPT indicated that the ability to perceive structured sound is developed individually. It was urged that the WADT not rely on the cumulative Total Different Test score, but that each section of the test be scored independently to avoid misdiagnosis of children's auditory discrimination abilities. (DO)

ED032131

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INITIAL AND FINAL CONSONANT RELATIONSHIPS IN SPEECH-SOUND TESTS: A DISCRIMINATION OR RESPONSE SET PROBLEM? [1]

Alan R. Coller, Richard Coleman, and Sol Schwartz [2]

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INSTITUTE FOR DEVELOPMENTAL STUDIES
New York University
School of Education

AUTHOR IDENTIFICATION

Alan R. Coller received his M.A. degree in 1963 from the New School for Social Research. At present he is an Associate Research Scientist at the Institute for Developmental Studies.

Richard Coleman received his B.A. degree in 1955 from New York University. At present he is a Research Scientist at the Institute for Developmental Studies.

Sol Schwartz received his Ph.D. degree in 1961 from the University of Michigan. At present Dr. Schwartz is an Associate Professor at the School of Education of the City University of New York.

Many investigators have studied the relationship between auditory discrimination ability and reading and speech performance. Significant relationships between these two sets of variables have been reported by Travis and Rasmus (1931), Reid (1947), Anderson (1949), Kronvall and Diehl (1954), Harrington and Durrell (1955), Scheifelbush and Lindsey (1958), Ayer (1960), Wepman (1960), Farquhar (1961), Cohen and Diehl (1963), Katz and Deutsch (1963), Christine and Christine (1964), Kronvall (1966), and Lichtenberg (1966). However, contradictory findings have been reported by Hall (1938), Hansen (1944), Mase (1946), Reynolds (1953), Prins (1963), and Aungst and Frick (1964), indicating that the relationship between these variables is neither perfect nor simple.

Exploratory investigations carried out by the present authors appear to shed some light on one of the possible sources of these contradictions. For example, although word-pair-type auditory discrimination tests are usually scored by summing up all incorrect responses to word pairs that are phonemically different, our exploratory findings suggest that this total score may be made up of heterogeneous components. That is, word pairs with phonemic changes at the beginning of the words are responded to differently from word pairs with phonemic changes at the end of the words.

Similar findings have been reported by others, using different types of tests. Templin (1943) and Pronovost and

Dumbleton (1953) examined the relationship between initial and final consonants in auditory discrimination tests, demonstrating that children made more errors when the critical speech sounds occurred at the end rather than at the beginning of words. However, they relate these differences to a problem of discrimination. Thus, Pronovost and Dumbleton conclude that "the findings ... agreed with the generally accepted idea that sounds are discriminated with more difficulty when in the final position than when in the initial position (p. 262)." Although Templin does not strictly come to such a conclusion, she does state that her study was conducted "to determine whether there was any variation in the ability of children to discriminate between identical and unlike syllables when the position of the discriminative element changed from the initial to the ... final position (p. 127)."

We feel that interpreting these results as a problem in discrimination can lead to the misdiagnosis of many children and this misdiagnosis can, in turn, lead to finding contradictory relationships between auditory discrimination ability and reading and speech performance.

The present study was undertaken to examine the relationship between initial and final consonants on two "equivalent" forms of the Wepman Auditory Discrimination Test. The speech sounds occur in meaningful words and the respondents are disadvantaged children. This particular population was chosen for investigation because reports by Deutsch (1963) and by Clark

and Richardson (1966) indicate that disadvantaged children have poorer "auditory discrimination" than do non-disadvantaged children. We anticipated finding results similar to those of the earlier investigators as well as of our own exploratory studies.

METHOD

SUBJECTS

The subjects for this study were selected from the first grade population of four schools located in the Harlem area of New York City. The subjects were 128 English-speaking Negro boys and girls whose parents were classified as belonging to the lowest socio-economic status (SES) groups. SES is based upon an equally-weighted combination of educational and occupational status of the family's main support, and is determined from the Index of SES, developed at the Institute for Developmental Studies. In all cases, the children who participated in this study did so with parental permission. As far as could be ascertained by an examination of record cards none of the children had any major hearing defect.

TEST

The Wepman Auditory Discrimination Test (WADT) is a carefully constructed test consisting of two equated forms. Each of the forms contains forty word-pairs; word-pairs used in one form do not occur in the other form. In each form there are thirty pairs of words which differ by a single phoneme and ten

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word-pairs which do not differ. S is asked to listen to each of the forty word pairs and to indicate whether each pair is the same (the same word repeated), or different (two different words).

The thirty "different" word pairs which make up what we call the Total Different Test (TDT) differ from one another in either the initial or final consonants (e.g., pool-tool, shot-shop), or in the medial vowel (e.g., pet-pit). The thirteen word pairs which differ from each other only by an initial consonant-phoneme change we call the Initial Phoneme Test (IPT). The thirteen word pairs which differ from each other only by a final consonant-phoneme change, we call the Final Phoneme Test (FPT). The remaining four word pairs which differ from each other only by a medial vowel-phoneme change, we call the Medial Phoneme Test (MPT).

The twenty-six word-pairs differing in either the initial or final consonant positions have been carefully combined. The phonemes to be compared and distinguished belong to the same phonetic category. No cross-phonetic category matching was done. For example, voiced stops are only combined with other voiced stops, and never with an unvoiced stop or nasal, etc. In all, the WADT contains thirteen different phonemic combinations: (1) three voiced stops: g-b, d-b, g-d; (2) three unvoiced stops: k-p, t-p, k-t; (3) one voiced fricative v-ð; (4) five unvoiced fricatives: f-θ, f-s, s-θ, s-ʃ, θ-ʃ; (5) one nasal: m-n.

Each of the thirteen different phonemic combinations occur once in the initial position and once in the final position. For example, in Form II, the unvoiced stop combination of the t-p occurs once in the initial position (in the word-pair tin-pin) and once in the final position (in the word-pair cat-cap). This bi-positional phonemic balance control is identical for both forms of the WADT.

The WADT is usually scored by counting the number of times S indicates that word-pairs are the same when, in fact, they are different. This latter procedure leads to an "error" score. Failure to indicate that word-pairs are the same when they are the same is used to check for response sets or for inattention to the task. Wepman (1958) indicates that protocols showing sixteen or more errors for different pairs, or four or more errors for same pairs should be put aside as invalid. He claims that "Children with scores in this range are thought to have either a hearing defect, or such poor motivation that they did not follow the instructions. Children of lower intelligence, or occasionally those with very poor discrimination, will also make scores in this range (p. 2)." However, it should be noted that lower SES, urban Negro children were not included in Wepman's standardization population and that norms for this group are not available.

INSTRUMENTATION

RECORDING OF THE MATERIAL Both forms of the WADT, including instructions, were recorded in a soundproof recording studio.

Each form was recorded on an individual tape.

The following recording criteria were observed: (1) that the loudness of each word of a pair should not be substantially different from the other, (2) that the loudness between pairs should not be substantially different, (3) that the presentation time between each word of a pair should be constant throughout all the pairs, (4) that the presentation time between pairs should be constant throughout all the pairs, and (5) that the final part of each word should be emphasized to compensate for the linguistic tendency to lower the voice at the end of words.

PLAYBACK The tapes were played at a constant auditory level on a Tandberg 74B tape recorder. The children listened to the tapes through earphones with the volume indicator set at a point beyond that of ordinary conversation.

ADMINISTRATION OF THE TEST MATERIALS

The test materials were administered in a room free from distractions. To put the child at ease, E explained the purposes for the various pieces of equipment. The child was told that he would wear earphones just like an astronaut, and would be told that he was going to listen to words and that he would have to listen very carefully. After the child listened to the instructions over the earphones, E asked the child if he understood what he was to do. In cases where there was doubt, E provided the child with additional sample pairs.

The presentation of the WADT tape took about twelve minutes. Half of the 128 children were randomly assigned to form I and half to Form II. An equal number of boys and girls listened to each of the forms. If for any reason a child could not be tested, a substitute was assigned to his place.

SCORING

The criteria set by Wepman for treating protocols as invalid were not followed in this investigation. The following criteria were used instead: (1) fewer than six correct on the same test, or (2) fewer than eight correct on the total different test, and more than eight correct on the same test. These are much more lenient criteria than those set by Wepman. Almost a third of the sample would have failed to meet the criterion of more than fifteen total different test pairs correct. In the absence of norms for lower SES urban Negro children, we felt that the original criteria would unduly penalize our subjects. The results are in terms of correct scores.

RESULTS

The data from this study were evaluated by means of a three-way analysis of variance, with repeated measurements on each of the subjects; each S received a score for the IPT and a score for the FPT.

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INSERT TABLE I ABOUT HERE
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From Table I, we see that there were no significant main effects for Sex or Form, indicating that the performance of the boys and girls was essentially the same, and that the claim that Forms I and II of the WADT are equivalent was substantiated. In addition, there were no significant interaction effects.

The statistically significant main effect for Test ($p < .001$) indicates that the childrens' score on the IPT and FPT differed significantly from each other. Examination of the means (see Table II) shows that we anticipated correctly; children obtained higher correct scores on the IPT than on the FPT.

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INSERT TABLE II ABOUT HERE
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The results of this investigation are very clear: there are no apparent differences between Form I and Form II. Further, the disadvantaged children of this study obtained significantly higher scores on the IPT than on the FPT. This latter result supports the findings of Templin and of Pronovost and Dumbleton, as well as our own exploratory studies.

The significant differences between the IPT and FPT indicates that the TDT score of the WADT is composed of at least two different tests. In this study, the TDT score is disproportionately influenced by error contributed by the FPT. It is not inconceivable that a child may do well on the IPT and poorly on the FPT, thereby confounding the meaning of the TDT score. An example of one such case is that of Robert. Robert's protocol is unique in its extremeness, but the relationship between the IPT and FPT scores is by no means unusual. Robert missed all 4 of the MPT items

and 12 of the 13 FPT items. The combined MPT and FPT error score adds up to 16 -- Wepman's criterion for invalid WADT protocols. Nevertheless, Robert obtained a perfect score on the IPT. This was not a chance finding, for when Robert was retested the next day, he again obtained a perfect score on the IPT, missed all 4 MPT items, and missed all but 2 of the 13 FPT items.

Compare Robert's performance with that of Jimmy who also missed a total of 16 items. Jimmy missed 5 IPT items, 4 MPT items and 7 FPT items. It should be obvious that these two protocols refect different orders of performance. Robert's protocol places us in somewhat of a different dilemma. On the one hand, we may conclude that Robert has excellent speech-sound ability -- a perfect score on the IPT. Indeed, of the entire sample of 128 children tested, only 3 children, Robert included, obtained a perfect score on the IPT. On the other hand, we may conclude that Robert has very poor speech-sound ability -- his near total failure on the FPT. However, if we merely look at the TDT score, we must treat both Robert's and Jimmy's protocols as invalid. The simple conclusion that both Robert and Jimmy have poor speech-sound ability would have to ignore the obvious pattern differences that distinguish their protocols.

It would be difficult to conclude that Robert was poorly motivated, since this motivation would have to be differentially

applied to the beginnings and endings of words. Nor can we apply a criterion of low intelligence to this differential performance. The postulation of some sort of differential hearing defect would be unparsimonious, to say the least. The issue, then, is whether we are measuring speech-sound discrimination per se or whether the respondents response pattern is a reflection of some other process.

Earlier we reported that the investigation by Templin and by Pronovost and Dumbleton were concerned with issues of speech-sound discrimination. Essentially, these investigators assumed that their results showed that phonemic differences are more difficult to <u>discriminate</u> when they occur at the terminal part of words. In order for this latter interpretation to be accepted with any degree of confidence one must also believe that it is possible for the respondent to correctly discriminate between, say, the phonemes <u>p-t</u>, when they occur at the beginning of words, but not when they occur at the end of words.

What would account for such a phenomenon? One possibility would be the linguistic tendency for final sounds to be articulated with less loudness than initial sounds. This explanation may be dismissed for this study on two counts: (1) the final parts of the words were especially articulated to control for such an eventuality, and (2) the level at which the respondents listened to the tapes was at a point much beyond that of ordinary conversation.

The context in which the critical speech-sounds are embedded will have an effect upon the discrimanability of speech sounds. When we combined all the IPT word-pairs from both WADT forms, and ranked them as to their relative difficulty, we found, for example, that din-bin was ranked 1.5 and bead-deed 12. Similarly, moon-noon was ranked 10.5 and map-nap 23. An argument suggesting that FPT items were embedded in relatively more difficult contexts than the IPT items can be developed. However, such an argument would have to hold for both the Templin and Pronovost and Dumbleton Tests as well as for the two forms of the WADT. Even in the unlikely event that such an argument is valid, it still does not follow that phonemic difference are more difficult to discriminate when they occur at the terminal parts of words. Differences between the IPT and FPT would be due to effects of contextual differences.

To assume that the WADT is a measure of speech-sound discrimination ability requires that the effective stimulus for the respondent be the two phomemes that differ from one another. If we cannot determine this, we cannot meaningfully conclude that the respondent has either "good" or "poor" speech-sound ability. With this in mind, Robert's performance could be interpreted as demonstrating that he did not treat the final parts of the word-pairs as effective stimuli. His perfect performance on the IPT suggests that he was treating the initial part of the word-pairs as the effective stimuli,

that he was responding to phonemic differences that occur at the beginnings of words. If, in fact, he was carrying over this skill to FPT items, where initial phonemes are identical, we would expect his FPT score to be very low. Thus, Robert's speech-sound discrimination ability may be very good, but by responding to an aspect of the stimulus different from what E expects, he achieves a low score. Unfortunately, the available data is not sufficient to conclude whether Robert merely "tuned out" (did not hear) the ending, or simply did not respond to differences he, in fact, heard.

Any interpretation of speech-sound discrimination ability based solely upon the TDT score of the WADT must ignore such a possibility and is, therefore, descriptively incomplete. On the basis of our findings and their interpretation, we strongly urge that the TDT score of the WADT, or of any similar test of speech-sound discrimination ability be broken down into its component parts and subjected to a pattern-analysis. Not to do so can conceivably lead to the misdiagnosis of many individuals.

TABLE I. Analysis of Variance of IPT and FPT Scores

Source of Variation	df	MS	F
Between S's:			
(A) Sex (Boys vs. Girls)	1	14.06	1.27
(B) Form (I vs. II)	1	9.00	1
(AB) Sex x Form	1	0.99	1
Error Bet. S's	124	11.03	--
Within S's:			
(C) Test (IPT vs. FPT)	1	138.06	39.90*
(AC) Sex x Test	1	1.56	1
(BC) Form x Test	1	0.56	1
(ABC) Sex x Form x Test	1	7.57	2.19
Error within S's	124	3.46	--

*p=<.001

TABLE II. Means and Standard Deviations of WADT Scores*

		FORM I		FORM II	
		IPT	FPT	IPT	FPT
Boys	$\bar{x}$	10.38	8.31	10.44	9.25
	S.D.	2.47	3.21	1.69	2.94
Girls	$\bar{x}$	10.47	9.41	10.97	9.41
	S.D.	2.12	3.15	1.81	3.25

*n=128: 64 boys and 64 girls

SUMMARY

Previous investigators demonstrated that children made more errors when the critical speech sounds occurred at the end rather than at the beginning of words. The present authors administered the Wepman Auditory Discrimination Test to disadvantaged Negro children, and replicated the earlier findings.

Whereas the earlier investigators interpreted their results in terms of discrimination, the present authors offer an alternative explanation. They suggest that certain children do treat the beginnings of words as effective stimuli but do not treat the final parts of words as effective stimuli. Because of prevailing scoring systems, children falling into this latter group are thought to have "poor" auditory discrimination ability, when, in fact, they may have a problem unrelated to discrimination.

The authors also feel that the Effective Stimulus Hypothosis may help to understand the contradictory results so often found in studies dealing with the relationship of speech-sound discrimination and speech and reading ability.

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ACKNOWLEDGEMENTS

1. This research was supported partially by an Aquinas Fund grant to Dr. Leo Goldstein and by a Carnegie Fund grant to Dr. Cynthia Deutsch. We would like to thank both Drs. Deutsch and Goldstein for their support and their many helpful suggestions. Thanks are due also to J. Gorrell, A. Luckett, M. McArdle, P. Schneider, S. Tehan and H. Tilis for their assistance in various phases of this study. We would also like to thank the Board of Education of New York City, especially Dr. E. Shapiro of P.S. 92, Mr. M. Weinstein of P.S. 180, Mr. R. L. Kahn of P.S. 154, and Mrs. Cohen of P.S. 124.

2. Now at the City University of New York.